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ABSTRACT

Measures of the Halstead-Reitan Neuropsychological Battery (HRNB) were factor analyzed with subtests of the Halstead Category Test (HCT) for 277 9-year-old learning disabled subjects. Eight factors with eigenvalues greater than one were rotated to a final solution that accounted for 67.9 percent of the total variance. HCT-Subtest 1 loaded primarily on a factor that was composed of measures of attention and/or impulse control. HCT-Subtest 2 was best identified with a factor that concerned visual-spatial analysis and memory. The remaining HCT subtests loaded on two factors independently of other HRNB variables. Equal loading, but with opposite signs, was found for NCT-Subtests 3 and 4 on a single factor. An additional factor consisted of HCT-Subtest 5 (negative loading) and HCT-Subtests 6 and 7 (positive loadings). These data were interpreted as offering little support for considering the subtests of the HCT as a single measure. Examination of error scores on Subtest 5 showed that an initial difficulty in identifying the underlying concept in that subtest may have a beneficial learning effect on succeeding subtests. Statistical results are summarized in the attached tables. (Author/SLD)

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The Multidimensional Nature of the Halstead Category Test

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The Multidimentional Nature of the Halstead Category Test

Abstract

Measures of the Halstead Reitan Neuropsychological Battery (HRNB) were factor analyzed with subtests of the Halstead Category Test (HCT) for 277 nine year old learning disabled subjects. Eight factors with eigenvalues greater than one were rotated to a final solution which accounted for 67.9 % of the total variance. HCT-subtest 1 loaded primarily on a factor which was composed of measures of attention and/or impulse control. HCT-subtest 2 was best identified with a factor that concerned visual-spatial analysis and memory. The remaining HCT subtests load on two factors independent of other HRNB variables. Equal loading, but with opposite signs, was found for HCT subtests 3 and 4 on a single factor. An additional factor consisted of HCT-subtest 5 (negative loading) and HCT subtests 6 and 7 (positive loadings). These data were interpreted as offering little support for considering the subtests of the HCT as a single measure. Examination of error scores on Subtest 5 showed that an initial difficulty in identifying the underlying concept in that subtest may have a beneficial learning effect on succeeding subtests.

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The Multidimensional Nature of the Halstead Category Test

The Halstead Category Test (HCT) is one of twenty seven tasks developed by Halstead (1947) to measure biological intelligence. Further validity research reduced this list to the ten measures which best identified subjects with brain damage (Reitan, 1969). The HCT is viewed by many (Dean, 1985; Golden, 1979) as the mainstay of the Halstead-Reitan Neuropsychological Battery (HRNB) and is one of four HRNB subtests shown to be the most sensitive to generalized brain impairment without regard to specific localization of the lesion (Reitan & Wolfson, 1985). The HCT has also been variously described as a measure of problem solving ability, attention, concentration, counting skills, memory, conceptual ability (Golden, Osmon, Moses, & Berg, 1981), and learning (Boll, 1981).

There is general agreement that the HCT is a highly complex psychological instrument measuring a variety of constructs (Reitan & Davison, 1974; Reitan & Wolfson, 1985; Lezak, 1983) . Although the HCT total error score has been shown to load primarily with such perceptual organization measures as the Wechsler Block Design and Picture Arrangement subtests in factor analytic studies (Lansdell & Donnelly, 1977; Goldstein & Shelly, 1972; Royce, Yeudall, & Bock, 1976; Cullum, Steinman, & Bigler, 1984; Aftanas & Royce, 1969), secondary loadings have been reported on factors such as non-verbal reasoning (Russell, 1982) and language skills

(Goldstein & Shelly, 1972).

Even though the HCT is comprised of seven subtests, clinical interpretations and most factor analytic studies are generally based on a single composite score (Landsdell & Donnelly, 1977; Swiercinsky, 1978; Fischer, D'Amato, Gray, & Dean, 1987). This single error score is formed without benefit of psychometric evidence. In fact, the variability in the factor loading of the HCT, reported above, may well be related to the heterogeneity of the subtests summed to produce the total score. This argument is supported in a factor analytic study of the HRNB with brain damaged adults (Royce et al., 1976). The results of this investigation showed the individual subtests of the HCT to load on a number of different factors. Since the Royce et al. study little has been published regarding the subtest specificity of the HCT. In the present study we were interested in replicating and extending the Royce et al. (1975) study with children. Such data would allow an examination of the constructs underlying this measure and to verify or challenge the validity of the total error score in clinical practice.

Method

Subjects and Procedures

The subjects for the analysis were 277 nine year old right handed children with learning problems drawn from an urban school system in a Midwestern state. Males represented 76.8 percent of the sample. Elements of the HRNB, including the seven subtests of the adult version of the HCT, were

administered to each subject. Means and standard deviations for each measure are listed in Table 1.

Insert Table 1 about here

Results

Data for each of twenty three variables were factor analyzed via a principal components routine. Factors with eigenvalues equal to or greater than 1.0 were retained and submitted to a varimax rotation. Factor loadings of .30 or greater were considered to be interpretable and are reported in Table 2 (Nunnally, 1978). The results showed eight

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Insert Table 2 about here

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eight factors to emerge accounting for 67.9 % of the total variance. The seven HCT subtests, circled in Table 2, loaded on five of the eight factors. Inspection of these data showed that HCT-subtest 1 loaded moderately on Factor 2 which appears to measure attention and/or impulse control. HCT-subtest 2 had minimal loading on Factor 4 with measures of visual-spatial memory. The remaining five HCT subtests loaded on factors independent of other HRNB variables. Specifically subtests 3 and 4 loaded equally but in opposite directions on Factor 8 while HCT-subtests 5, 6, and 7 had relatively high loadings on Factor 3 with subtests 6 and 7 loading positively and 5 loading negatively.

Table 3 presents the zero order correlations between HCT subsets and summary scales of the Wechsler Intelligence Scale for Children-Revised. An examination of this data revealed a

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Insert Table 3 about here

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significant relationship between PSIQ and HCT-subtest 5 but not with either HCT-subtests 6 or 7. This finding suggests that a categorization of Factor 3 as merely a measure of perceptual organization is too simplistic. The zero order matrix also supports findings from previous research (Cullum et al., 1984) that the HCT-composite score may be more closely related to measures of fluid than crystallized intelligence.

Discussion

The primary purpose of the present study was to examine the nature and number of constructs underlying the HCT. Although the test is generally reported as a single score, its complexity has long been recognized by both researchers and clinicians. Nevertheless, little attention has been paid to specific contributions the HCT subtests might make in understanding the cognitive abilities of the patient.

A number of constructs were identified. HCT-subtest 1 loaded with measures of attention, impulse control and freedom from distractibility. Poor performance on this subtest would seem to indicated difficulties reflective of conditions such as attention disorders and progressive

dementia (Reitan & Wolfson, 1985). HCT-subtest 2 loaded moderately on a factor described as a measure of visual-spatial memory and perceptual organization. Again, poor performance on measures of incidental memory are expected in cases of neurological impairment and may represent an index of the degree of severity (Reitan & Wolfson, 1985). HCT-subtests 3 and 4 and subtests 5, 6, and 7 loaded on two separate factors independent of any other variables making it difficult to define the underlying construct. It is interesting to note, however, that HCT-subtest 7, traditionally viewed as a memory test, did not load on the incidental memory factor defined by TPT-Memory and TPT-Location. The data support the consideration of subtest scores when interpreting the HCT. However, further research would seem necessary to define the underlying constructs.

Of possible major significance were the findings relating to Factors 3 and 8. There were near equal but opposite sign loadings of HCT subtests 3 and 4 on Factor 8 and HCT subtests 5, 6, and 7 on Factor 3. The inconsistent and negative correlations between HCT subtests gave reason to consider the influence of early errors on later performance. As a precursor to conditional probabilities, two groups were formed on the basis of scores on the HCT subtest 5 (< 9 errors, > 11 errors). An examination of the mean differences between these groups showed that children with less than 9 errors on Subtest 5 had significantly ($p < .05$) greater errors on Subtest 6 ($\bar{X} = 16.54$, $SD = 7.20$) and 7 ($\bar{X} = 5.99$,

SD = 3.44) than subjects who had more than 11 errors on Subtest 6 ($\bar{X}$ = 9.21, SD = 4.29; Subtest 7 ($\bar{X}$ = 2.83, SD = 1.68). These data seem to imply that those subjects (group 1) who experience greater initial difficulty on a conceptual task, prior to discovering an appropriate solution, may perform better on succeeding tasks than their more successful counterparts (group 2). Conclusions on this Ho: await replication with other samples and a further analysis of conditional probabilities between subtests.

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Table 1

Means and Standard Deviations for HRNB Subtests Administered To a Sample of 277 Nine Year Old Right Handed Learning Disabled Subjects

Subtests	$\bar{X}$	SD
Trails A (Errors)	.36	.73
Trails B (Errors)	1.31	1.66
Grip (R.H.)	11.72	3.50
Grip (L.H.)	10.94	5.10
Category 1	.91	1.06
Category 2	.82	.85
Category 3	22.53	10.00
Category 4	11.95	8.65
Category 5	10.00	9.69
Category 6	12.09	8.03
Category 7	4.01	3.92
TPT - Memory	4.93	1.02
TPT - Localization	3.85	1.74
S. S. Perception	19.00	10.02
Tapping (D.H.)	28.43	5.67
Tapping (N.D.H.)	26.27	5.19
Seashore Rhythm (R.S.)	19.44	4.80
Trails A (Time)	22.92	9.15
Trails B (Time)	71.21	55.81
TPT (D.H.)	308.91	186.79
TPT (N.D.H.)	196.28	142.78
TPT (B.H.)	83.17	52.52
TPT (Total)	590.06	325.69

Table 2

Factor Loadings of HRNB Variables Including Category Subtests 1 through 7 for a Sample of 277 Nine Year Old Right Handed Learning Disabled Subjects

Tests	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
TPT - (Total)	96							
TPT - (D.H.)	84							
TPT - (N.D.H.)	80							
TPT - (B.H.T.)	70			38				
Trails B (Errors)		82						
Trails B (Time)		78						
Category 1		(55)						
Seashore (R.S.)		- 51			39			
S.S. Perception		.50					31	
Category 5			- (82)					
Category 6			(78)					
Category 7			(76)					
TPT - Memory				- 86				
TPT - Location				- 83				
Category 2				(36)				
Tapping (D.H.)					86			
Tapping (N.D.H.)					86			
Grip (R.H.)						85		
Grip (L.H.)						82		
Trails (A (Errors)							81	
Trails B (Time)							76	
Category 4						- (31)		- (75)
Category 3								(73)

[a] Only loadings of .30 or above are reported and all decimal points have been suppressed.

[b] Category subtest loadings are circled

Table 3

Intercorrelations Among WISC-R I.Q. and Halstead Category Test Scores for a Sample of 219 Nine Year Old Right Handed Learning Disabled Subjects

Measures	1	2	3	4	5	6	7	8	9	10	11
1. WISC(R) - V.IQ	1.00	.44**	.86**	-.31**	-.15*	-.14**	.01	-.01	-.10	-.05	-.16**
2. WISC(R) - P.IQ		1.00	.83**	-.30**	-.28**	-.19**	-.14*	-.17**	-.04	-.07	-.33**
3. WISC(R) - F.S.IQ			1.00	-.36**	-.25**	-.19**	-.07	-.11*	-.09	-.07	-.29**
4. HCT- Subtest 1				1.00	-.19**	.08	.06	.02	.11	.13*	.23**
5. HCT - Subtest 2					1.00	.13*	-.07	-.03	.09	.16**	.16**
6. HCT - Subtest 3						1.00	-.18**	-.10	.21**	.29**	.59**
7. HCT - Subtest 4							1.00	.17**	-.06	-.08	.43**
8. HCT - Subtest 5								1.00	-.41**	-.41**	.30**
9. HCT - Subtest 6									1.00	.59**	.44**
10. HCT - Subtest 7										1.00	.40**
11. HCT - Composite											1.00

* $p < .05$

** $p < .01$

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